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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/724,438	11/28/2003	Hyungiun Kim	YOR920030207US1	1230
7590 05/19/2005			EXAMINER	
David Aker 23 Southern Road Hartsdale, NY 10530			STEVENSON, ANDRE C	
			ART UNIT	PAPER NUMBER
			2812	
DATE MAILED: 05/19/2005				

Please find below and/or attached an Office communication concerning this application or proceeding.

<b>Office Action Summary</b>	Application No. 10/724,438	Applicant(s) KIM ET AL.	
	Examiner Andre' C. Stevenson	Art Unit 2812	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --  
**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

#### Status

- 1) ☒ Responsive to communication(s) filed on 28 November 2003.
- 2a) ☐ This action is FINAL.                      2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

#### Disposition of Claims

- 4) ☒ Claim(s) 1-35 is/are pending in the application.
- 4a) Of the above claim(s) 31-35 is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-12, 15-26, 29 and 30 is/are rejected.
- 7) ☒ Claim(s) 13, 14, 27, 28 is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

#### Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 28 November 2003 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

#### Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All    b) ☐ Some \* c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

\* See the attached detailed Office action for a list of the certified copies not received.

#### Attachment(s)

- |   |  |
|---|--|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892)   | 4) <input checked="" type="checkbox"/> Interview Summary (PTO-413)<br>Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948)  | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152)                        |
| 3) <input checked="" type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)<br>Paper No(s)/Mail Date <u>11/28/03</u> . | 6) <input type="checkbox"/> Other: _____   |

## **Detailed Action**

### ***Election/Restrictions***

During a telephone conversation with David Aker on May 02, 2005 a provisional election was made without traverse to prosecute the invention of Group I, claims 1-30. Affirmation of this election must be made by applicant in replying to this Office action. Claims 31-35 have been withdrawn from further consideration by the examiner, 37 CFR 1.142(b), as being drawn to a non-elected invention.

### ***Information Disclosure Statement***

The information disclosure statement (IDS) submitted on November 28, 2003 was filed before the first action on the merits. The submission is in compliance with the provisions of 37 CFR 1.97. Accordingly, the information disclosure statement is being considered by the examiner.

### ***Claim Rejections - 35 USC § 112***

The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

The term "substantially", in claim 9, 15, 17, 23 and 30, is a relative term, which renders the claims indefinite. The terms "period" and "temperature" are not defined by the claim, the specification does not provide a standard for ascertaining the requisite degree, and one of ordinary skill in the art would not be reasonably apprised of the scope of the invention. As follows:

**Claim #9**

“Substantially two seconds”.

**Claim #15**

“Substantially 10 minutes”.

**Claim #17**

“Substantially 350<sup>0</sup> C”.

**Claim #23**

“Substantially 10 minutes”.

**Claim #30**

“Substantially 350<sup>0</sup> C”.

***Claim Rejections - 35 USC § 103***

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

Claims 1-7, 10-12, 15-21, 24-26, 29 and 30 are rejected under 35 U.S.C. 103(a) as being unpatentable over Fair (U.S. Pat. No.6,849,122 B1, Patented 02/01/05, Filed 03/07/02), above, and in view of Buskirk et al. (U.S. Pat. No.6,010,744, Patented 01/04/00, Filed 12/23/97).

Fair substantially shows the claimed invention, as shown in figures 1-6 and corresponding text, in a similar method, **pertaining to claim #1**, a method for depositing

Art Unit: 2812

ruthenium on a substrate (Abstract; **column 5, lines 37-44**), and depositing ruthenium on the exposed substrate by atomic layer deposition (**column 3, lines 56-67; column 4, lines 1-15**).

*Pertaining to claim #2*, Fair shows, a method of claim 1, wherein the substrate is selected from the group consisting of silicon dioxide, methyl silsesquioxane, hydrogen silsesquioxane, other low dielectric constant materials, and high dielectric constant oxide substrates (**column 6, lines 55-65**). *Pertaining to claim #3*, Fair shows, method of claim 1, wherein said plasma is an oxygen plasma (**column 10, lines 24-36**). *Pertaining to claim #4*, Fair shows, a method wherein the oxygen plasma is generated by passing molecular oxygen through a plasma generation source to produce activated radicals to thereby generate a large number of nucleation sites on said substrate (**column 10, lines 24-36**). *Pertaining to claim #5*, Fair shows, a method, wherein said plasma is a nitrogen plasma (**column 10, lines 24-36**). The Examiner notes that the prior art fails to mention explicitly a “nitrogen” plasma. However, it does state in column 10, line 26-29, that the liberation of the ligand or otherwise removing of the organic moieties can be accomplished with a flux of atomic oxygen or other highly reactive oxidizing species. The Examiner takes the position that Nitrogen falls within the category of other highly reactive oxidizing species, and that to one of ordinary skill in the art at the time the invention was created, it would be a matter of choice to have chosen Nitrogen instead of oxygen as a reactive oxidizing agent to remove any organic moieties. For this reason, the Examiner takes the position that the two are equivalent.

*Pertaining to claim #6*, Fair shows, a method of claim 5, wherein the nitrogen plasma is generated by passing molecular nitrogen through a plasma generation source to produce activated radicals to thereby generate a large number of nucleation sites on said substrate (**column 10, lines 24-36**). The Examiner notes that the prior art fails to mention explicitly a

Art Unit: 2812

“nitrogen” plasma. However, it does state in column 10, line 26-29, that the liberation of the ligand or otherwise removing of the organic moieties can be accomplished with a flux of atomic oxygen or other highly reactive oxidizing species. The Examiner takes the position that Nitrogen falls within the category of other highly reactive oxidizing species, and that to one of ordinary skill in the art at the time the invention was created, it would be a matter of choice to have chosen Nitrogen instead of oxygen as a reactive oxidizing agent to remove any organic moieties. For this reason, the Examiner takes the position that the two are equivalent. *Pertaining to claim #7*, Fair shows, a method of claim 1, wherein said atomic layer deposition is performed by alternating steps of: exposing the substrate to a ruthenium precursor for a first predetermined period of time (**column 9, lines 45-52**); and exposing the substrate to a plasma for a second predetermined time (**column 10, lines 24-36**). *Pertaining to claim #10*, Fair shows, a method, wherein the ruthenium precursor is selected from the group consisting of: ruthenium cyclopentadienyli, bis (ethylcyclopentadienyl) ruthenium); and ((2,4-dimethylpentadienyl) ethylcyclopentadienyl) ruthenium) plasma (**column 9, lines 55-67; column 10, lines 1-8**). *Pertaining to claim #11*, Fair shows, a method, wherein the ruthenium precursor is carried in a carrier gas (**column 9, lines 55-67; column 10, lines 1-8**). *Pertaining to claim #12*, Fair shows, a method, wherein the carrier gas is argon (**column 9, lines 45-52**). *Pertaining to claim #15*, Fair shows, method, wherein said exposing of said substrate to said plasma is performed for substantially 10 minutes or longer (**column 10, lines 24-44**). *Pertaining to claim #16*, Fair shows, a method, wherein said substrate is heated to a temperature of between 200 and 400<sup>0</sup> C (**column 9, lines 16-34; column 11, lines 37-52**). *Pertaining to claim #17*, Fair shows, a method, wherein said substrate is heated to a temperature of substantially 350<sup>0</sup> C (**fig. #5**;

**column 11, lines 37-52).** *Pertaining to claim #18*, Fair shows, a method wherein said ruthenium is deposited directly on said substrate without use of a seed layer (**column 5, lines 37-44**).

*Pertaining to claim #19*, Fair shows, a method for depositing ruthenium on a substrate, comprising (**abstract; column 5, lines 37-44**): performing plasma enhanced atomic layer deposition of ruthenium on the substrate using a ruthenium precursor and a plasma to form a thin film of ruthenium (**column 4, lines 16-27; column 6, lines 13-25**); and depositing ruthenium on the thin film by thermal Atomic layer deposition (**column 9, lines 55-67; column 10, lines 1-8**).

*Pertaining to claim #20*, Fair shows, method, wherein said plasma is a hydrogen plasma (**column 3, lines 41-46; column 10, lines 45-58**). *Pertaining to claim #21*, Fair shows, a method, wherein said atomic layer deposition is performed by alternating steps of: exposing the substrate to a ruthenium precursor for a first predetermined period of time (**column 9, lines 45-52**); and exposing the substrate to a plasma for a second predetermined time (**column 10, lines 24-36**). *Pertaining to claim #24*, Fair shows, a method, wherein the ruthenium precursor is selected from the group consisting of: ruthenium cyclopentadienyi, bis (ethylcyclopentadienyl) ruthenium); and (2, 4 dimethylpentadienyl)ethylcyclopentadienyl) ruthenium). (**column 9, lines 55-67; column 10, lines 1-8**). *Pertaining to claim #25*, Fair shows, method, wherein the ruthenium precursor is carried in a carrier gas (**column 9, lines 55-67; column 10, lines 1-8**). *Pertaining to claim #26*, Fair shows, a method wherein the carrier gas is argon (**column 9, lines 45-52**). *Pertaining to claim #29*, Fair shows, a method, wherein said substrate is heated to a temperature of between 200 and 400<sup>0</sup> C (**column 9, lines 16-34; column 11, lines 37-52**). *Pertaining to claim #30*, Fair shows a method, wherein said substrate is heated to a temperature of substantially 350<sup>0</sup> C (**fig. 5; column 11, lines 37-52**).

Fair fails to show, **with respect to claim #1**, exposing the substrate to a plasma, which causes a high concentration of nucleation sites to be formed on the substrate, thus forming an exposed substrate;

Buskirk teaches, in a similar method, **pertaining to claim #1**, exposing the substrate to a plasma, which causes a high concentration of nucleation sites to be formed on the substrate, thus forming an exposed substrate (**column 2, lines 66, 67; column 3, lines 1-28; column 5, lines 52-67; column 6, lines 1-6 & 16-30**).

It would have been obvious to one having ordinary skill in the art, at the time the invention was made, with respect to **claims #1**, to include exposing a substrate to a plasma, which causes a high concentration of nucleation sites to be formed on the substrate, in the method of Fair, as taught by Buskirk, with the motivation that having high density nucleation sites is essential to attaining deposition of films with controllable composition and uniform morphology.

Claims 8, 9, 22 and 23 are rejected under 35 U.S.C. 103(a) as being unpatentable over Fair (U.S. Pat. No.6,849,122 B1, Patented 02/01/05, Filed 03/07/02) and Buskirk et al. (U.S. Pat. No.6,010,744, Patented 01/04/00, Filed 12/23/97), as applied to claims 1-7, 10-12, 15-21, 24-26, 29 and 30 in the USC 103(a) rejection above, in further view of Ruzic (U.S. Pat. No.6,841,044, Patented 01/11/05, Filed 11/04/02).

Fair and Buskirk substantially shows the claimed invention in the corresponding text and drawings listed in the USC 103 rejection above.



Fair and Buskirk fail to teach, with respect to **claim #8 and 22**, a method, further comprising evacuating the ruthenium precursor and the plasma between successive steps, and with respect to **claim #9 and 23**, wherein the evacuation is done for a period of substantially two seconds.

**Pertaining to claim #8**, Ruzic shows, a method, further comprising evacuating the ruthenium precursor and the plasma between successive steps (**column 6, lines 61-67**).

*Pertaining to claim #9*, Ruzic shows, a method, wherein the evacuating is done for a period of substantially two seconds (**column 6, lines 61-67**). *Pertaining to claim #22*, Ruzic shows, a method, further comprising evacuating the ruthenium precursor and the plasma between successive steps (**column 6, lines 61-67**). *Pertaining to claim #23*, Ruzic shows, a method, wherein the evacuating is done for a period of substantially two seconds (**column 6, lines 61-67**). The Examiner takes notice that Ruzic does not explicitly state evacuating the ruthenium precursor and plasma between successive steps for a period of two seconds. However, Ruzic teaches a method wherein a pump (item #167) is employed to evacuate the chamber when necessary, as for example, between cycles of an ALD process. The Examiner takes the position, with respect to claims #8 and 22, that Ruzic's method of being able to evacuate the chamber, when ever necessary, as between cycles of a process, affords the user the choice of when, or between which procedures, to evacuate. Also, the disclosure fails to point out any criticality of the evacuation to the invention, other than to mention on page 5, lines 25-27, that the process takes place. The Examiner takes the position that the choice of when to evacuate the chamber is incessantly available; thus, the two are equivalent. Also, in light of the disclosures description of the amount of time to "pump out", found on page 10, lines 16-21, where the applicant states that

Art Unit: 2812

“these conditions are provided only by way of example”, with respect to claims 9 and 23, the Examiner takes the position that the choice of how long to run the evacuation of the chamber is also a matter of user choice.

It would have been obvious to one having ordinary skill in the art, at the time the invention was made, with respect to **claims #8, 9, 22 and 23**, to include evacuating the ruthenium precursor and the plasma between successive steps, where the evacuations is done for a period of substantially two seconds, in the method of Fair and Buskirk, as taught by Ruzic, with the motivation that evacuating the chamber between successive steps for any amount of time necessary to clean the chamber, would prevent contamination by components from a previous process.

### **Allowable Subject Matter**

Claims 13, 14, 27 and 28 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims, pending further search.

#### **Claims #13 and 27**

- ✓ First predetermined period of time is 4 seconds.

**Claims #14 and 28**

- ✓ Second predetermined period of time is 2 seconds.

**Conclusion**

The prior art made of record and not relied upon is considered pertinent to applicant's disclosure; Sophie et al. (U.S. Pat. No. 6,878,628), Lee et al. (U.S. Pat. No. 6,696,363), Papa Rao et al. (U.S. No. 2005/0048776), ~~Papa~~ Kim et al. (U.S. No. 6,812,042), Shang et al. (U.S. No. 6,887,776), Soininen et al. (U.S. No. 6,887,795), Ohtani et al. (U.S. No. 6,589,824), Girardie et al. (U.S. No. 6,727,138), Anhdideh et al. (U.S. No. 6,664,168).

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Andre' Stevenson whose telephone number is (571) 272 1683. The examiner can normally be reached on Monday through Friday from 7:30 am to 4:30 pm.

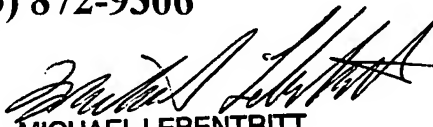
If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Michael S. Lebentritt, can be reached on (571) 272 1873. The fax phone number for the organization where this application or proceeding is assigned is (703) 308 7724.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 308 0956. Also, the proceeding numbers can be used to fax information through the Right Fax system;

**(703) 872-9306**

Andre' Stevenson

05/12/05

  
MICHAEL LEBENTRITT  
SUPERVISORY PATENT EXAMINER